Effect of Imidacloprid Tree Treatments on the Occurrence of Formosan Subterranean Termites, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae), in Independent Monitors

WESTE L. A. OSBRINK[1] AND ALAN R. LAX

Southern Regional Research Center, USDA–ARS, 1100 Robert E. Lee Blvd., New Orleans, LA 70124

J. Econ. Entomol. 96(1): 117–125 (2003)

ABSTRACT Periodic sampling of 87 independent monitors, initially active with the Formosan subterranean termite, *Coptotermes formosanus* Shiraki, was conducted. Monitors, located in eight sectors adjacent to seven buildings, were various distances (1–46 m) from 57 trees treated with 0.1% imidacloprid foam. Termites collected from six of the eight sectors showed latent mortality attributed to imidacloprid intoxication at all monitor-tree distances. Approximately 6 mo after treatment, termite populations had recovered in these sectors. Another sector showed termite population suppression for ≈15 mo, followed by recovery. Imidacloprid tree treatments did not control *C. formosanus* populations in independent monitors adjacent to the treatments.

KEY WORDS *Coptotermes formosanus*, termite, imidacloprid, foam, trees

TOTAL ECONOMIC LOSS DUE to termites in the United States was estimated at $1.7 billion per year (Gold et al. 1996). The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is native to Asia (Bouillon 1970), but has been introduced into the southern United States where it has become a devastating pest (Su and Tamashiro 1987). *C. formosanus* infestations of living trees are common in the New Orleans, LA area (Osbrink et al. 1999). These infestations go undetected until the termite population becomes so great as to cause structural failure of the tree or the occurrence of some external signs such has mudding of cut or broken limb scars or the appearance of dispersal flight launching tubes during the spring swarming season. Control of termite populations in trees is critical because of the danger of falling trees or tree limbs, the esthetic and historic importance of trees to greater New Orleans, and the threat of these termite populations moving into and destroying urban structures (Osbrink et al. 1999). One hypothesis suggests that termites will continue to forage into treatments of slow-acting, nonrepellent insecticide, resulting in elimination of termite populations in areas adjacent to the treatments (Thorne and Breisch 2001). One such slow-acting, nonrepellent insecticide is the new generation neonicotinoid imidacloprid (Matsuda et al. 2001). Imidacloprid, a nicotine analog, is an insect specific agonist of nicotinic acetylcholine receptors that appears to be nonrepellent to termites (Thorne and Breisch 2001, Matsuda et al. 2001). The objective of this research was to determine if treatment of trees with this new generation, slow-acting, nonrepellent insecticide would control *C. formosanus* populations in areas adjacent to those treatments.

Materials and Methods

In 1999, the ≈40 ha University of New Orleans (New Orleans Parish, LA) lakeside campus was surveyed for subterranean termites using with placement of pine stakes (2 by 4 by 20 cm) resulting in 87 bucket trap termite monitors (Su and Scheffrahn 1986) active with *C. formosanus* (Fig. 1). Termites were identified from Scheffrahn and Su (1994) and Su et al. (1997). On 10–15 March 2000, pest management professionals drilled and foamed 57 trees (Fig. 1) with 0.1% imidacloprid (Premise). Criteria for tree treatment was >25 cm diameter with a cavity to accept the foam. Foam was applied to fill the tree cavity until foam was expelled from companion holes, the volume varied with each application. A number of tree species were treated including live oak, *Quercus virginiana* Mill; hybrid oaks, *Quercus* spp.; Baldcypress, *Taxodium distichum* Rich; maples, *Acer* spp.; pine, *Pinus* spp.; birch, *Betula* spp.; mulberry, *Morus* spp.; magnolia, *Magnolia* spp.; and palms of unknown spp. Tree treatments and monitors were grouped into eight sectors located

This article reports the results of research only. Mention of a proprietary product does not constitute an endorsement or recommendation by the USDA for its use.

[1] E-mail: osbrink@srrc.ars.usda.gov.

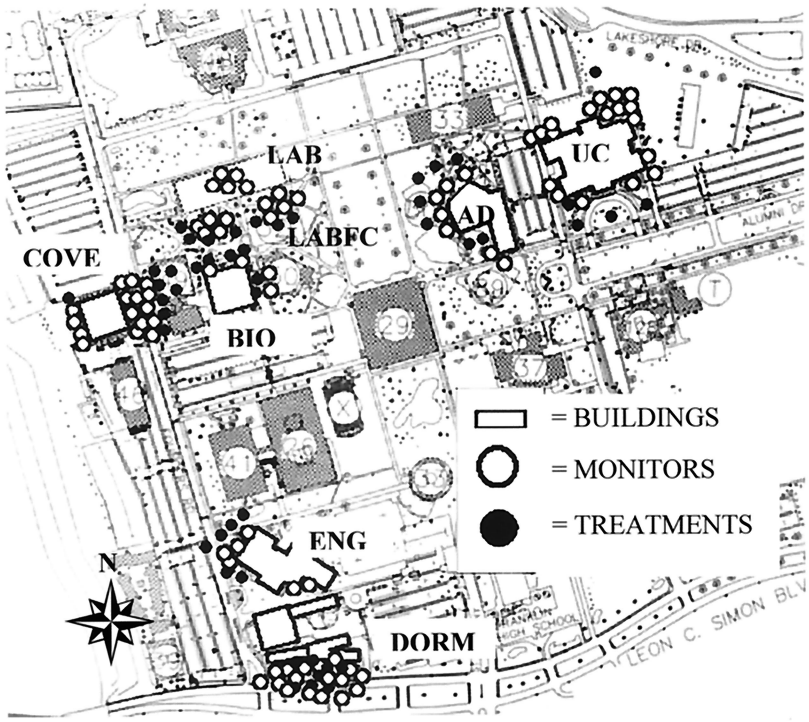

Fig. 1. Map of University of New Orleans indicating locations of *C. formosanus* traps (open circles), treated trees (solid circles), and relevant buildings (open polygons).

around seven buildings (Fig. 1; Table 1). Sectors were defined as follows: Administration building (Ad.), Cove, Liberal Arts Building atrium (L.A.B.), Liberal Arts building Friendship Circle (L.A.B.F.C.), University Center (U.C.), Biology building (Bio.), Engineering building (Eng.), and Dormitory (Dorm). Beginning February 2000, *C. formosanus* were collected from monitors approximately monthly and maintained in the laboratory on stacked, moistened spruce (*Picea* sp.) slats (10 by four by 0.5 cm) in plastic containers (13 × 13 × 4 cm) at ≈100% RH and ≈27°C. Healthy termites fed, produced carton material, sought harborage, and survived for months. Termites intoxicated with imidacloprid did not feed, produce carton material, seek harborage, or survive beyond 14 d. When this latent mortality was incorporated into statistical analysis, figures, or tables, a negative value was tabulated and assigned to the collection date. Number of workers collected from each monitor was estimated by subtracting the total weight of soldiers and brachypterous nymphs from the total weight of termites collected (individual weights calculated by weighing four groups of 10 workers, soldiers, and brachypterous nymphs). Mean number of workers collected per sampling date was calculated from total workers collected per sector and analyzed with analysis of variance (ANOVA). Means were separated using an unprotected Fisher least-significant difference (least significant difference [LSD]) test ($P < 0.05$; PROC GLM, SAS Institute 1990). Mean number of workers per monitor per sector per collection date was calculated by dividing number of workers collected by number of monitors per sector and analyzed using ANOVA (PROC GLM, SAS Institute 1990). Means were separated using an unprotected LSD test ($P < 0.05$; PROC

Table 1. U.N.O. *C. formosanus* monitors and treated trees

Location	No. traps	Trees		After treatment % monitors with termites all dates combined mean (± SD)[a]
		No.	Distance (m)[b]	
Ad.	7	7	1–30	42.9 ± 9.2ab
Cove	16	8	3–30	39.0 ± 16.6abc
L.A.B.	5	8	30	27.7 ± 16.2c
L.A.B.F.C.	10	8	1–8	53.3 ± 14.0a
U.C.	19	5	1–46	35.4 ± 14.7bc
Bio.	4	7	1–12	47.8 ± 19.8ab
Eng.	6	6	6–30	50.0 ± 19.0a
Dorm	20	8	2–12	9.0 ± 14.2d
				$F = 12.58$
				df = 7, 112
				$P < 0.0001$

[a] Means followed by the same letter are not significantly different, LSD; $P < 0.05$.

[b] Trap to treated tree minimum distances in meters (m).

Table 2. All *C. formosanus* workers trapped

Date	Termites trapped (Mean ± SD) × 1,000[a]				% monitors with termites
	Total No.	Total No. (−)[b]	Mean	Mean (−)	
2/08/00	1.4 ± 1.7a	1.4 ± 1.7Bc	0.1 ± 0.2e	0.1 ± 0.2def	11.7 ± 8.6e
3/28/00	12.8 ± 10.6a	8.5 ± 6.2abc	1.2 ± 0.7bcde	0.9 ± 0.8bcd	52.7 ± 15.3a
6/01/00	9.1 ± 9.9a	8.3 ± 10.2abc	1.2 ± 1.6bcde	1.0 ± 1.5bcd	36.0 ± 18.1abcd
6/14/00	8.5 ± 8.6a	−3.9 ± 6.8c	1.0 ± 1.4cde	−0.5 ± 1.0er	26.7 ± 27.5cde
6/28/00	11.5 ± 10.2a	−3.0 ± 10.2c	1.4 ± 1.6bcde	−0.7 ± 1.7f	31.3 ± 23.9cde
7/13/00	11.1 ± 8.9a	0.8 ± 7.8bc	1.3 ± 0.8bcde	0.1 ± 1.0def	30.4 ± 21.4bcde
7/31/00	11.4 ± 12.8a	4.4 ± 8.0abc	1.0 ± 1.1cde	0.6 ± 0.8cdef	36.2 ± 21.5abcd
9/01/00	20.0 ± 16.6a	18.0 ± 16.8ab	2.4 ± 2.6ab	2.1 ± 2.6ab	45.0 ± 19.7abc
10/10/00	23.8 ± 31.5a	15.0 ± 14.2abc	1.3 ± 0.5bcde	1.2 ± 0.5bcd	46.4 ± 20.7ab
1/10/01	8.9 ± 5.4a	8.9 ± 5.4abc	0.8 ± 0.4de	0.8 ± 0.4cde	39.1 ± 17.8abc
2/20/01	10.5 ± 6.9a	10.5 ± 6.9abc	1.3 ± 1.1bcde	1.3 ± 1.1bce	37.2 ± 18.5abce
4/12/01	12.6 ± 10.7a	12.6 ± 10.7abc	1.6 ± 1.6bce	1.6 ± 1.6bc	40.0 ± 23.9abc
5/11/01	21.0 ± 9.1a	21.0 ± 9.1a	2.2 ± 1.1abc	2.2 ± 1.1ab	43.3 ± 17.8abc
6/11/01	22.8 ± 12.2a	22.8 ± 12.2a	3.0 ± 2.5a	3.0 ± 2.5a	43.6 ± 19.7abc
7/26/01	19.8 ± 12.9a	19.8 ± 12.9ab	1.6 ± 0.7bcd	1.6 ± 0.7bc	35.9 ± 17.7abc
8/20/01	15.1 ± 14.2a	15.1 ± 14.2abc	1.4 ± 1.3bcde	1.4 ± 1.3bce	28.2 ± 19.5bcde
	$F = 1.54$	$F = 4.06$	$F = 0.0257$	$F = 4.14$	$F = 2.07$
	df = 16, 119	df = 16, 119	df = 16, 119	df = 16, 119	df = 16, 119
	$P = 0.0967$	$P < 0.0001$	$P = 0.0257$	$P < 0.0001$	$P = 0.0142$

[a] Means within a column with the same letter are not significantly different, LSD; $P < 0.05$.
[b] Latent mortality assigned a negative value.

GLM, SAS Institute 1990). Proportion of monitors with termites per sector per collection date was calculated by dividing the number of monitors with termites by the total number of monitors in the sector. After treatment mean proportion of monitors with termites by sector, all dates combined, was transformed by arcsine square root and analyzed by ANOVA with means separated using an unprotected LSD test ($P < 0.05$; PROC GLM, SAS Institute 1990) and converted back to percentage. Pearson correlation coefficient was computed between number of workers trapped or number of workers displaying latent mortality and trap-tree distance.

Results and Discussion

Diagnostic behavioral changes and latent mortality attributed to imidacloprid intoxication of *C. formosanus* collected from monitors and maintained in the laboratory are consistent with studies on *Reticulitermes* sp. (Thorne and Breisch 2001, Boucias et al. 1996, Ramakrishnan et al. 2000). Combining all after treatment collection dates, the Dorm sector had significantly fewer monitors occupied by *C. formosanus* (9.0 ± 14.2%) than any other sector (>27%) over the 17-mo sampling regime (Table 1; Fig. 7). No significant reduction occurred in mean total number of termites collected for any date after treatment (Table 2).

Table 3. *C. formosanus* workers trapped by sector

Date	Termites trapped (Mean ± SD) × 1,000			
	Ad.	Cove	L.A.B.	L.A.B.F.C.
2/08/00	0.5 ± 1.4b	0.2 ± 0.6cde	0c	0.1 ± 0.2bce
3/28/00	0.1 ± 1.5b	0.8 ± 3.3bcde	1.3 ± 2.1abc	0.2 ± 0.4bce
6/01/00	0.5 ± 2.3b	0.1 ± 0.3de	0.8 ± 1.8bc	1.0 ± 1.5abc
6/14/00	0.1 ± 1.9b	−0.5 ± 1.5e	−0.4 ± 0.8c	−1.0 ± 2.0cd
6/28/00	0.4 ± 0.9b	0.2 ± 0.7cde	0c	−1.6 ± 2.9d
7/13/00	0.4 ± 2.9b	0.5 ± 3.3bcde	2.1 ± 4.6abc	−1.6 ± 2.3d
7/31/00	0.7 ± 1.2ab	−0.5 ± 1.8e	0.1 ± 0.2c	2.2 ± 4.3ab
9/01/00	1.6 ± 2.1ab	1.4 ± 2.0bc	1.9 ± 2.6abc	0.2 ± 4.2bce
10/10/00	1.2 ± 2.1ab	2.8 ± 3.2a	1.5 ± 2.2abc	1.3 ± 1.6ab
1/10/01	1.1 ± 1.9ab	0.7 ± 1.2bcde	1.4 ± 2.1abc	1.3 ± 1.3ab
2/20/01	0.9 ± 1.3ab	0.8 ± 1.3bcde	4.3 ± 6.7ab	2.0 ± 1.7ab
4/12/01	1.9 ± 3.5ab	0.3 ± 0.5cde	1.2 ± 2.0abc	0.7 ± 0.7abc
5/11/01	1.9 ± 2.5ab	1.8 ± 3.0ab	5.0 ± 5.1a	1.7 ± 1.6ab
6/11/01	3.2 ± 5.0a	1.3 ± 2.0bce	3.4 ± 5.1abc	2.8 ± 3.1a
7/26/01	1.7 ± 2.8ab	0.7 ± 1.6bcde	2.2 ± 3.8abc	1.3 ± 1.6ab
8/20/01	2.4 ± 3.3ab	1.5 ± 2.1bc	3.1 ± 4.2abc	0.4 ± 0.6bce
	$F = 0.90$	$F = 3.18$	$F = 1.19$	$F = 2.67$
	df = 16, 102	df = 16, 272	df = 16, 68	df = 16, 136
	$P = 0.5714$	$P < 0.0001$	$P = 0.2982$	$P = 0.0011$

Latent mortality assigned a negative value. Means within a column with the same letter are not significantly different, LSD; $P < 0.05$.

Table 4. *C. formosanus* workers trapped by sector

Date	Termites trapped (Mean ± SD) × 1,000			
	U.C.	Bio.	Eng.	Dorm
2/08/00	0.0 ± 0.1c	0bcde	0de	0.2 ± 0.4c
3/28/00	0.9 ± 1.6bc	2.0 ± 2.2bce	2.4 ± 2.8bce	0.3 ± 0.9c
6/01/00	0.9 ± 1.4bc	0bcde	4.7 ± 6.4abce	0c
6/14/00	0.2 ± 2.0c	−4.5 ± 8.6e	0de	0c
6/28/00	0.1 ± 1.9c	−2.3 ± 4.7de	−4.6 ± 7.2e	0.3 ± 1.2c
7/13/00	0c	−1.4 ± 2.5cde	0.2 ± 4.5cde	0.2 ± 0.7c
7/31/00	0.4 ± 3.1c	0.5 ± 1.0bcde	1.5 ± 2.0bce	0c
9/01/00	1.6 ± 2.5abc	1.3 ± 1.8bce	8.4 ± 7.9a	0c
10/10/00	1.3 ± 3.2bc	1.4 ± 1.5bce	1.4 ± 2.5bce	0.3 ± 1.2c
1/10/01	1.0 ± 2.6bc	0.1 ± 0.2bcde	0.6 ± 0.9cd	0.7 ± 2.0bc
2/20/01	0.4 ± 0.8c	2.1 ± 2.4bcd	1.6 ± 2.2bce	0c
4/12/01	1.3 ± 2.2bc	4.0 ± 6.2abc	5.0 ± 3.2abc	0c
5/11/01	1.0 ± 1.9bc	5.2 ± 3.6ab	1.5 ± 2.3bcd	2.0 ± 5.9ab
6/11/01	0.8 ± 1.5bc	9.5 ± 9.9a	6.2 ± 5.4ab	0.1 ± 0.4c
7/26/01	2.6 ± 4.4ab	1.2 ± 2.4bcde	2.7 ± 3.9bcd	0.8 ± 2.3bc
8/20/01	0.9 ± 1.7bc	0bcde	3.7 ± 6.6abcd	2.4 ± 5.3a
	$F = 1.45$	$F = 2.36$	$F = 2.83$	$F = 1.95$
	df = 16, 289	df = 16, 51	df = 16, 85	df = 16, 289
	$P = 0.1184$	$P = 0.0105$	$P = 0.0010$	$P = 0.0160$

Latent mortality assigned a negative value. Means within a column with the same letter are not significantly different, LSD; $P < 0.05$.

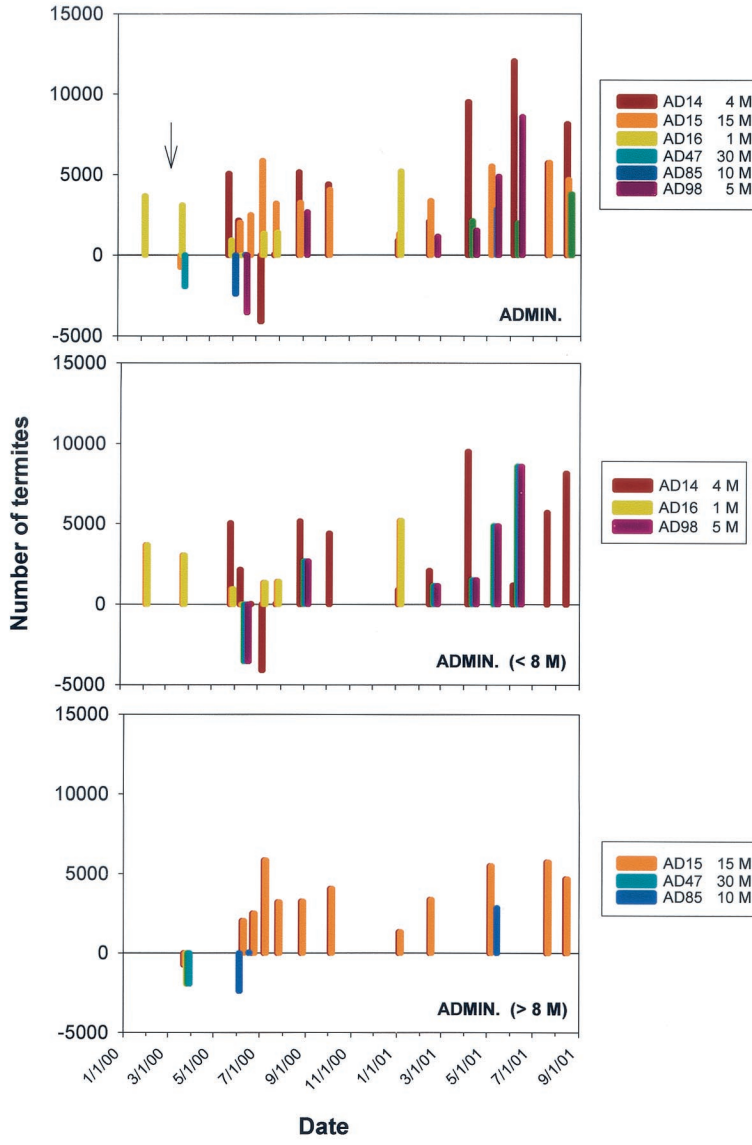

Fig. 2. Number of *C. formosanus* workers trapped in Ad. sector by trap and collection date. Latent mortality assigned a negative value. Trap to tree distance indicated in meters (M). Trees treated in March 2000 (arrow).

Incorporating latent mortality, only three collection dates (14 June, 28 June, and 13 July 2000) had a significantly lower total mean number of termites collected than May and June 2001. Average mean number of termites collected after treatment in 2000 was only significantly less than the 11 June 2001 collection (Table 2). Including latent mortality, only the average mean number of termites collected three and 4 mo after treatment (14 June 2000, 28 June 2000, and 13 July 2000) was significantly less than similar collection dates from the following year (Table 2). Significant reduction in the mean percentage of all traps with termites occurred only at 3–4 mo after treatment when compared with March 2000 (Table 2).

Incorporating latent mortality, the Admin. sector had significantly (LSD $P < 0.05$; ANOVA not significant) fewer termites collected 2 wk to 4 mo post-treatment (2000) compared with the 11 June 2001 collection (Table 3). Latent mortality occurred in collections from monitors both near (<8 m) and far (>8 m) from the treatments, with no time lag associated with increased distance (Fig. 2). There were no correlations either between number of termites col-

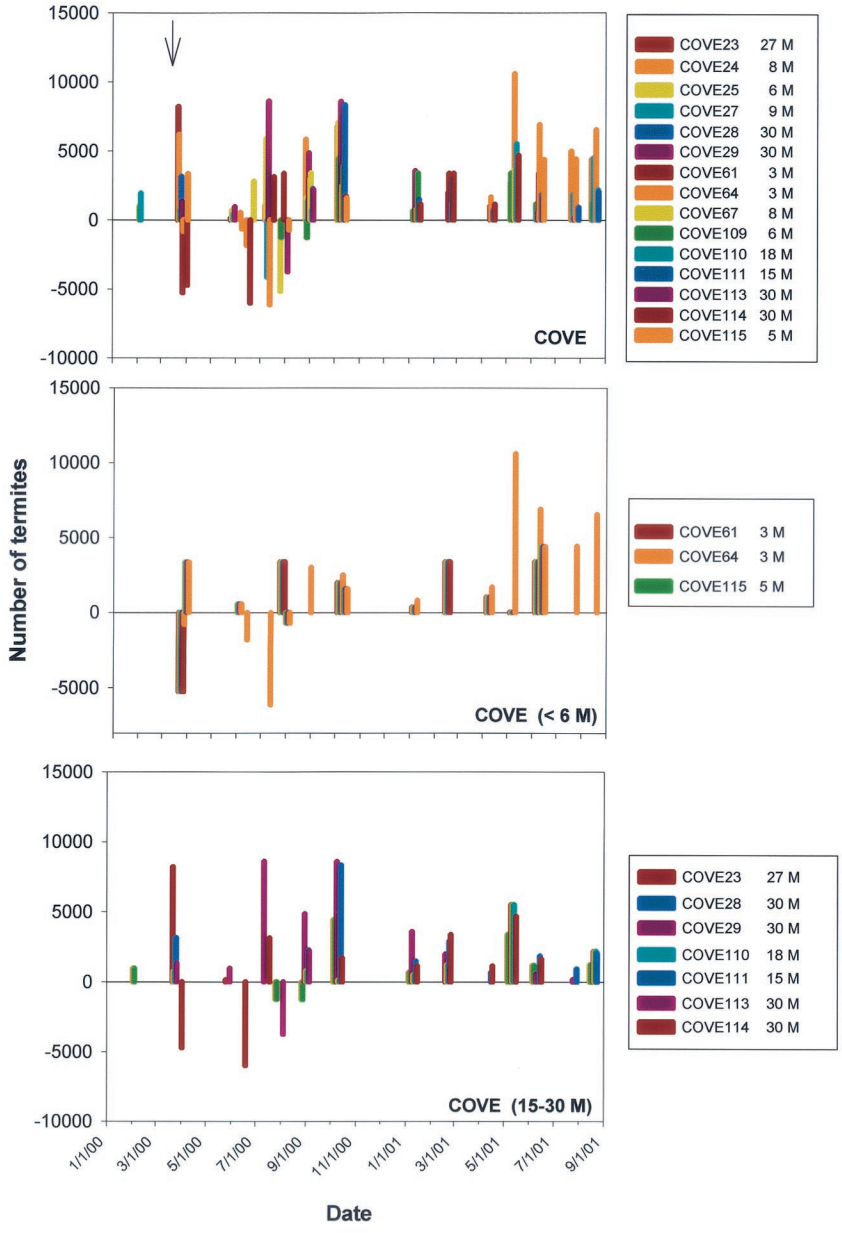

Fig. 3. Number of *C. formosanus* workers trapped in Cove sector by trap and collection date. Latent mortality assigned a negative value. Trap to tree distance indicated in meters (M). Trees treated in March 2000 (arrow).

lected or occurrence of latent mortality and monitor-to-treatment distance. Results were similar for the Cove, LAB., LAB.F.C., U.C., Biol., and Eng. sectors (Tables 3 and 4; Figs. 3). Numerous collections of negative and zero mean numbers of termites occurred in these sectors 3–4 mo after treatment (Tables 3 and 4; Figs. 2–6). The Dorm sector differed from the other seven sectors with significant suppression of termite populations lasting 14–15 mo after treatment (Table 4; Figs. 5 and 7).

With the exception of the Dorm sector, the effect of tree treatments on termite populations in areas adjacent to the treatments was short lived (<6 mo). The Dorm sector differed from the other sectors in being located in an ecological peninsula with three sides not conducive to termites. South and West of the Dorm were roads, and east was a parking lot (Fig. 1). Thus, repopulation of the Dorm sector probably occurred only from the North or from galleries bridging a sizable distance under the roads or parking lot. The different

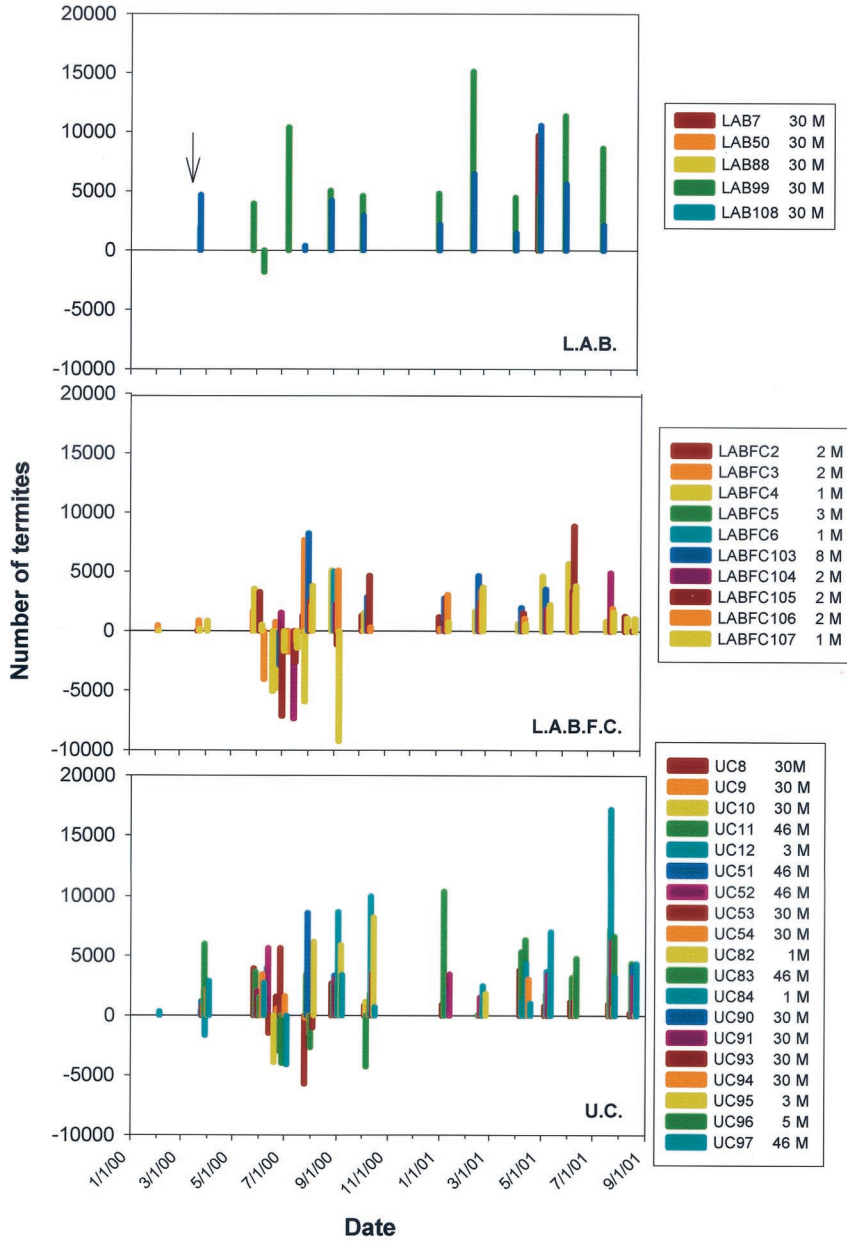

Fig. 4. Number of *C. formosanus* workers trapped in L.A.B., LAB.F.C., and U.C. sectors by trap and collection date. Latent mortality assigned a negative value. Trap to tree distance indicated in meters (M). Trees treated in March 2000 (arrow).

response of the termite population in the Dorm sector could also reflect a difference in insecticide susceptibility (Thorne and Breisch 2001, Ramakrishnan et al. 2000, Osbrink et al. 2001), or native entomopathogens (Boucias et al. 1996, Ramakrishnan et al. 1999).

The occurrence of imidacloprid-intoxicated termites 46 m from the treatment site, UC11 (Fig. 4), is remarkable. Foaming of trees potentially treats hundreds of thousands of *C. formosanus* directly (Osbrink et al. 1999), representing a profound challenge to the termite population. Imidacloprid is also transferred easily from living termites to intoxicate naive nest mates (Thorne and Breisch 2001) potentially resulting in spread of the toxicant throughout the population. Imidacloprid potentiates native entomopathogens (Boucias et al. 1996, Ramakrishnan

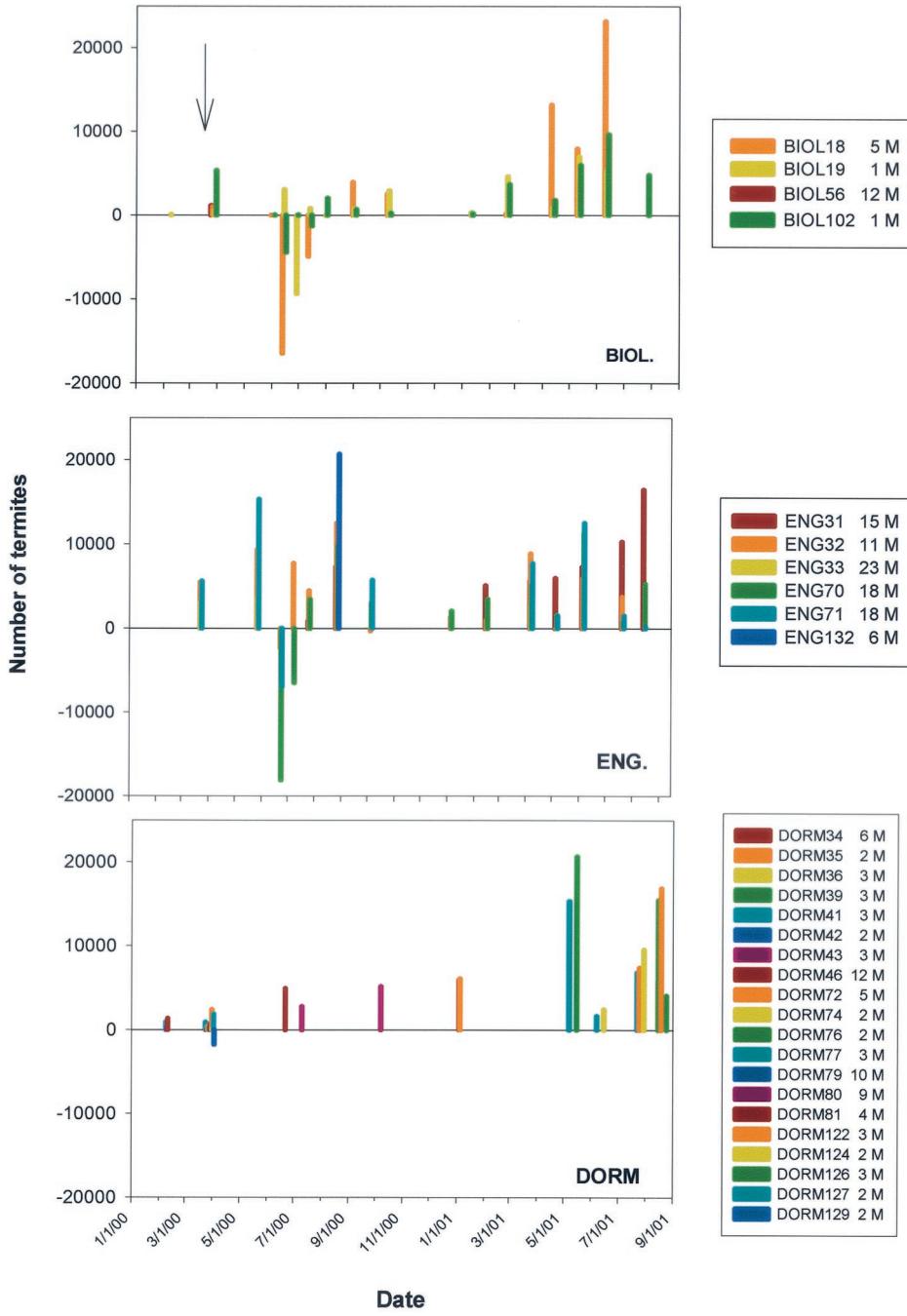

Fig. 5. Number of *C. formosanus* workers trapped in Bio., Eng., and Dorm sectors by trap and collection date. Latent mortality assigned a negative value. Trap to tree distance indicated in meters (M). Trees treated in March 2000 (arrow).

et al. 1999), further challenging the population. For populations to survive and recover, as shown in this study, termites must not have continued to forage in treated trees, or the toxicant is ephemeral. If imidacloprid is innately nonrepellent, secondary repellency may be occurring. Secondary repellency has been demonstrated with chlorpyrifos and attributed to the accumulation of dead termites (Su et al. 1982).

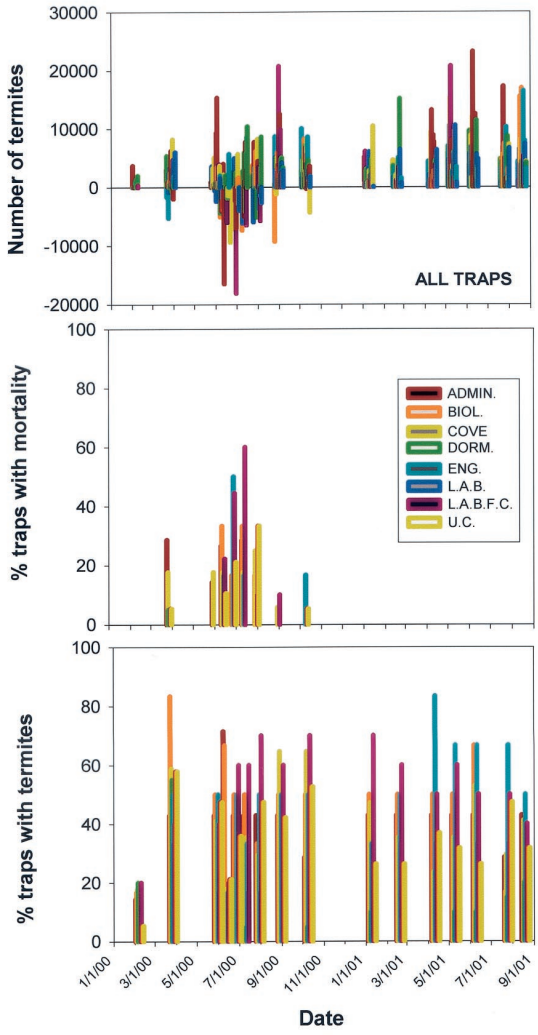

Fig. 6. Number of *C. formosanus* workers trapped in all sectors by monitor and collection date with latent mortality assigned a negative value (top). Percentage of traps producing workers that displayed latent mortality by sector and collection date (center). Percent traps which produced workers by sector and collection date (bottom).

Regardless, tree treatments with this new generation, slow-acting, nonrepellent insecticide did not control *C. formosanus* populations in areas adjacent to the treatments.

Acknowledgments

We thank M. Cornelius, M. Wright, and A. Appel for their invaluable assistance in reviewing drafts of the manuscript. We also thank A. Ballew for her technical assistance.

References Cited

Boucias, D. G., C. Stokes, G. Storey, and J. C. Penland. 1996. The effects of imidacloprid on the termite *Reticulitermes flavipes* and its interactions with the mycopathogen *Beauveria bassiana.* Pflanzenschutz-Nachr. Bayer 49: 103–144.

Bouillon, A. 1970. Termites of the Ethiopian region, pp. 153–280. *In* K. Krishna and F. M. Weesner [eds.], Biology of Termites, vol. 2. Academic, New York.

Gold, R. E., H. N. Howell, Jr., B. M. Pawson, M. S. Wright, and J. C. Lutz. 1996. Evaluation of termiticides residues and bioavailablity from five soil types and locations in Texas, pp. 467–484. *In* K. B. Wildey [ed.], Proceedings, 2nd International Conference on Insect Pests in the Urban Environment, 7–10 July 1996, Edinburgh, Scotland. BPC Wheatons Ltd., London, UK.

Matsuda, K., S. D. Buckingham, D. Kleier, J. J. Rauh, M. Grauso, and D. B. Sattelle. 2001. Neonicotinoids: insecticides acting on insect nicotinic acetylcholine receptors. Trends Pharmacol. Sci. 22: 573–580.

Osbrink, W.L.A., W. D. Woodson, and A. R. Lax. 1999. Population of Formosan subterranean termite, *Coptotermes formosanus* (Isoptera: Rhinotermitidae), established in living urban trees in New Orleans, Louisiana, U.S.A., pp. 341–345. *In* W. H. Robinson, F. Rettich, and G. W. Rambo [eds.], Proceedings, 3rd International Conference on Urban Pests, 19–22 July 1999, Prague, Czech Republic. Graficke zavody Hronov, Czech Republic.

Osbrink, W.L.A., A. R. Lax, and R. J. Brenner. 2001. Insecticide susceptibility in *Coptotermes formosanus* and *Reticulitermes virginicus* (Isoptera: Rhinotermitidae). J. Econ. Entomol. 94: 1217–1228.

Ramakrishnan, R., D. R. Suiter, C. H. Nakatsu, R. A. Humber, and G. W. Bennett. 1999. Imidacloprid-enhanced *Reticulitermes flavipes* (Kollar) (Isoptera: Rhinotermitidae) susceptibility to the entomopathogen *Metarhizium anisopliae* (Metsch.) Sorokin. J. Econ. Entomol. 92: 1125–1132.

Ramakrishnan, R., D. R. Suiter, C. H. Nakatsu, and G. W. Bennett. 2000. Feeding inhibition and mortality in *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). J. Econ. Entomol. 93: 422–428.

SAS Institute. 1990. A user's guide: statistics, version 6th ed. SAS institute, Cary, NC.

Scheffrahn, R. H., and N.-Y. Su. 1994. Keys to soldiers and winged adult termites (Isoptera) of Florida. Fla. Entomol. 77: 460–474.

Su, N.-Y., and R. Scheffrahn. 1986. A method to access, trap, and monitor field populations of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in the urban environment. Sociobiology 12: 299–304.

Su, N.-Y., and M. Tamashiro. 1987. An overview of the Formosan subterranean termite (Isoptera: Rhinotermitidae) in the world, pp. 3–15. *In* M. Tamashiro and N.-Y. Su [eds.], Biology and control of the Formosan subterranean termite. College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu.

Su, N.-Y., M. Tamashiro, J. Yates, and M. Haverty. 1982. Effect of behavior on the evaluation of insecticides for prevention of or remedial control of the Formosan subterranean termite. J. Econ. Entomol. 75: 188–193.

Su, N.-Y., R. Scheffrahn, and T. Weissling. 1997. A new introduction of a subterranean termite, *Coptotermes havilandi* Holmgren (Isoptera: Rhinotermitidae) in Miami Florida. Florida Entomologist 80: 408–411.

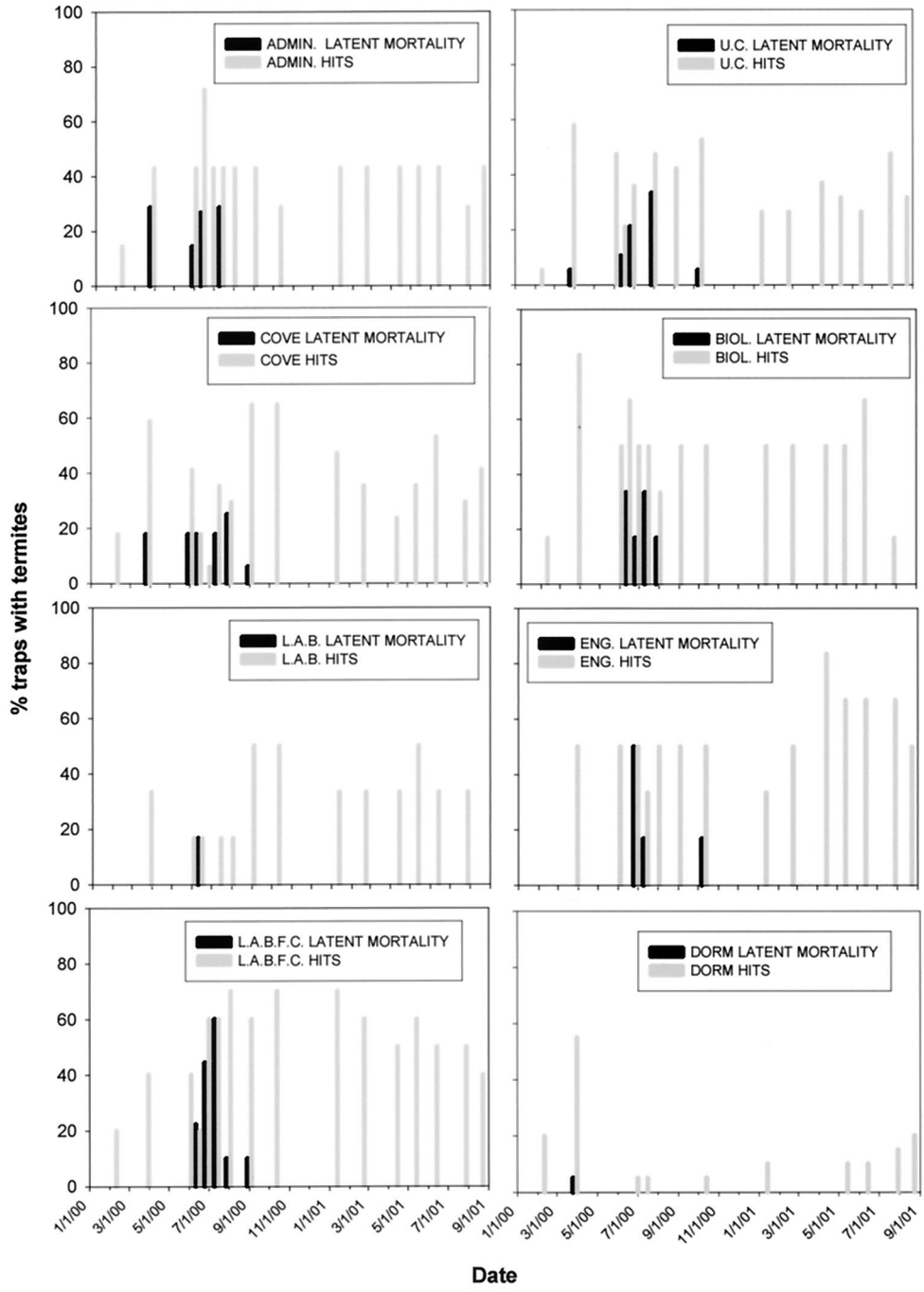

Fig. 7. Percent traps that produced *C. formosanus* workers and workers that displayed latent mortality by collection date and sector.

Thorne, B. L., and N. L. Breisch. 2001. Effect of sublethal exposure to imidacloprid on subsequent behavior of subterranean *Reticulitermes virginicus* (Isoptera: Rhinotermitidae). J. Econ. Entomol. 94: 492–498.

Received for publication 11 February 2002; accepted 3 September 2002.